reference report

PA model

- > “Can I Touch This?”: Survey of Virtual Reality Interactions via Haptic Solutions

4.1 Design space

We propose a two-dimension framework to discuss and classify haptic solutions in VR (see Table 1).

The first dimension is their *degree of physicality*, ie how the haptic perception is tangible/physically consistent/resembling with the virtual objects. This dimension is drawn as a continuum, from "no physicality" to "real objects" (see Figure 2). We find that this continuum can be discretised as a two-category section: whether they use real objects or not.

The second orthogonal dimension is their *degree of actuation*, ie whether haptic solutions rely on a motor-based hardware implementation enabling autonomous displacements (eg enabling to change its shape, position etc).

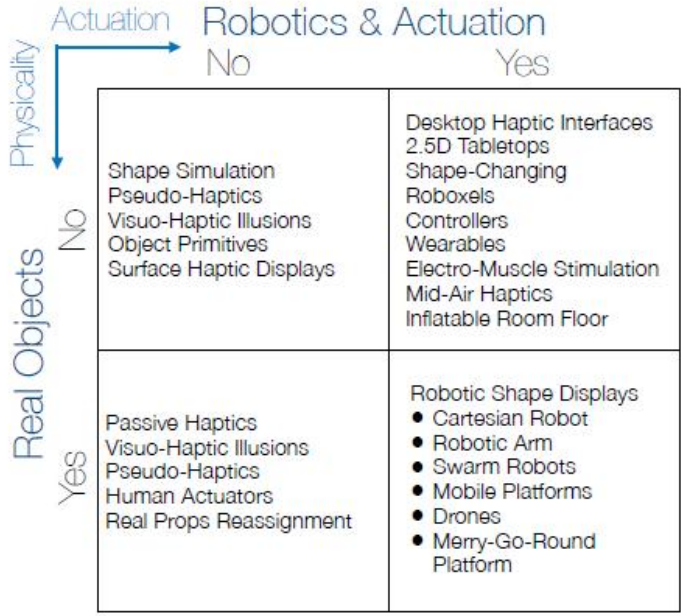
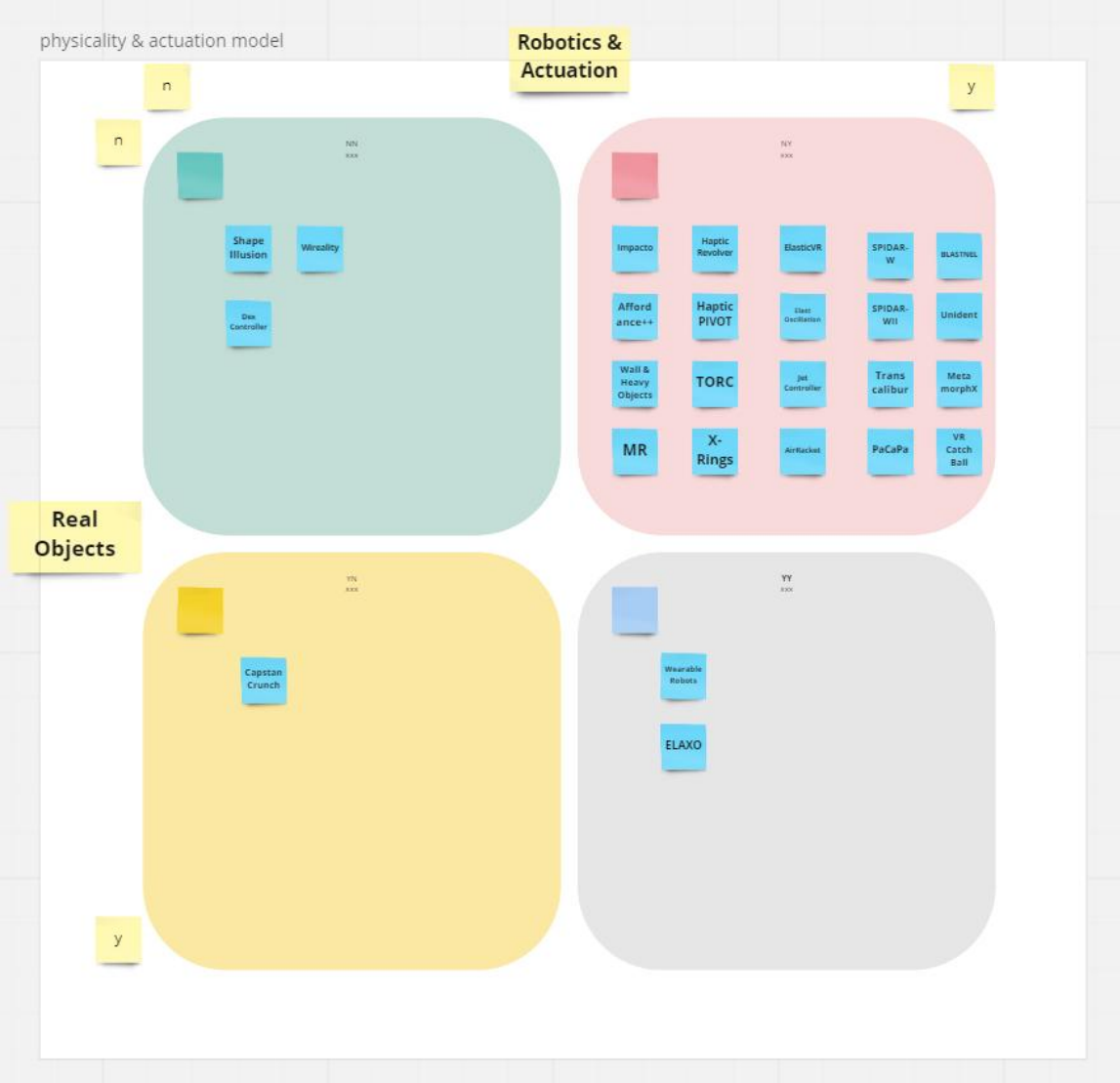


Table 1: We propose two dimensions to classify current technologies: their degrees of physicality and actuation.

catalog by PA model

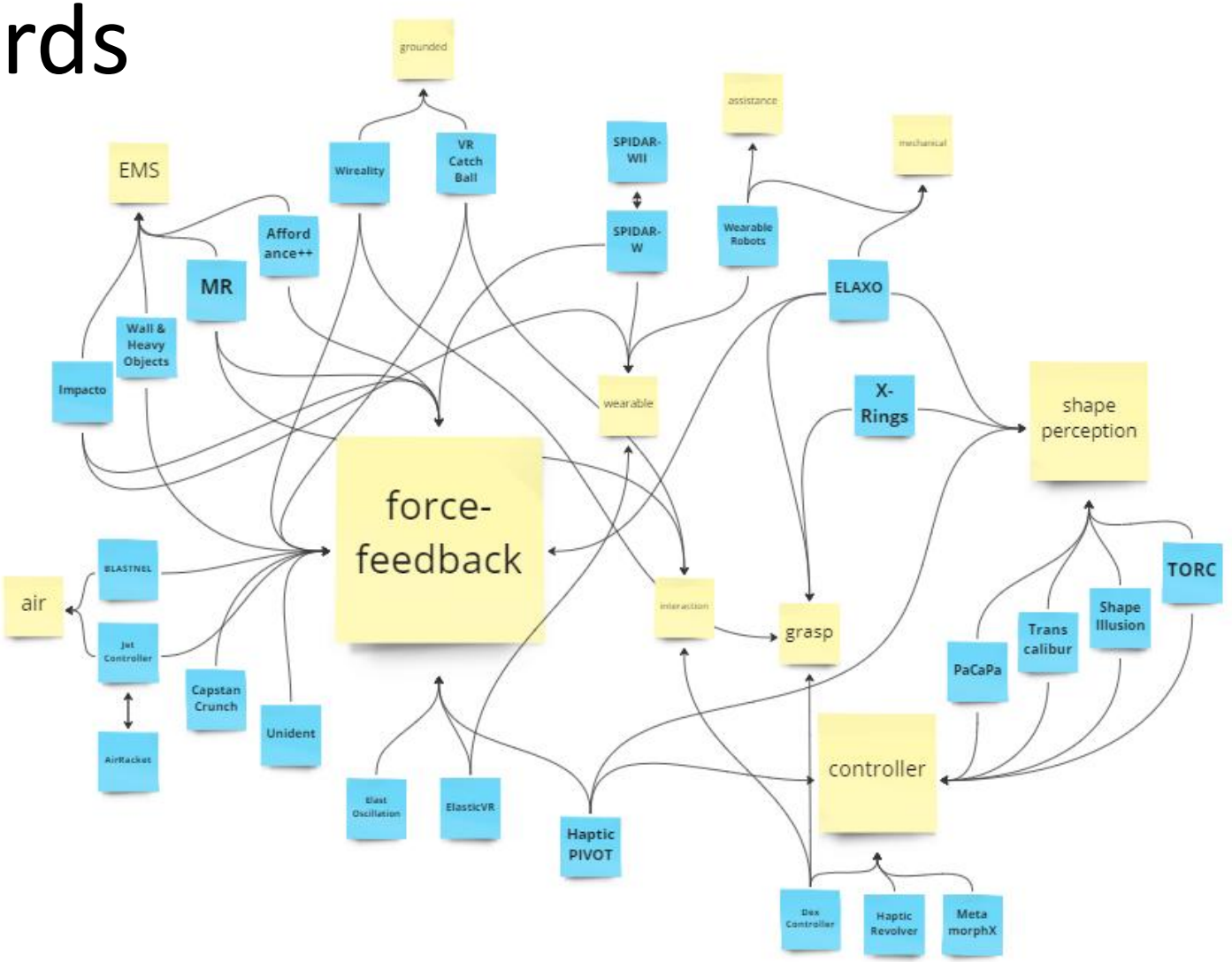


catalog by keywords

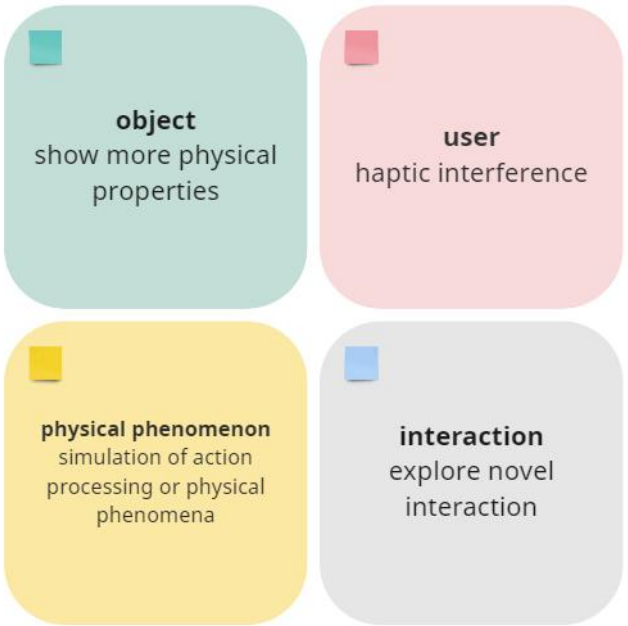
criteria：

- keyword
- abstract & introduction
- compared to others

*Not classified to the category when it is not mentioned the concept.



catalog by research object



research trends

object
show more physical properties

- Complex Tangible Geometries
- Damped Oscillation Feedback
- Haptic Shape Illusion
- 2D Shape Rendering
- Physical Properties Changing
- Walls & Heavy Objects
- High-dexterity Finger Interaction
- Shape Display
- Reconfigurable Shape Rendering
- Stiffness Rendering

Research Trends

- Focus on non-autonomous static objects
  e.g. apple, box, weapon, wall
- Focus on physical properties
  e.g. shape, texture, viscosity

Potential

- Autonomous objects
  e.g. vehicle, robot, human limbs
- Dynamic properties of objects
  e.g. direction of motion, velocity

physical phenomenon
simulation of action processing or physical phenomena

- Grasp Recognition
- Resistive Force feedback
- 3-DoF Force Feedback
- Directional Force Feedback
- Collision
- Impact Sensations
- Grasping Catching and Throwing

Research Trends

- Usually display one force
  e.g. impact, resistance
- Focus on the instant interaction
  e.g. the moment of strike or collision

Potential

- Plural forces condition
  e.g. forward driving force and backward resistance, the spatial relationship between the driving part and the object model
- Intermediate process display of the motion process
  e.g. the motion of a ball in the air

study case

pic	project	reference	limitaion
	Haptic PIVOT: On-Demand Handhelds in VR	Performance of the movement process,rendering grasping catching and throwing	1.Only can display the curved movement. 2.Limit to the size of the object.
	Unident: Providing Impact Sensations on Handheld Objects via High-Speed Change of the Rotational Inertia	Show the force condition of the object by moving the parts back and forth	1.Aim to siulate the impact not motion state display. 2.Cannot simulate the intermediate process of the movement.
	MetamorphX: An Ungrounded 3-DoF Moment Display that Changes its Physical Properties through Rotational Impedance Control	3-dof haptic display, show the characteristics of different objects through different force feedback	Represent the static characteristics of the target object by simulating the state of force, such as shape and mass, rather than being in a changing state of motion.
	JetController: High-speed Ungrounded 3-DoF Force Feedback Controllers using Air Propulsion Jets	3-dof force feedback, allow the user to perceive different forces feedback in different directions	Aim to high frequency movement, unable to simulate continuous movements.
	AirRacket: Perceptual Design of Ungrounded, Directional Force Feedback to Improve Virtual Racket Sports Experiences	directional force feedback	Single direction, aim to improve VR sports application.

abstract report

A continuous motion feedback controller

A controller that can continuously feedback the motion state of dynamic objects under VR environment

research question

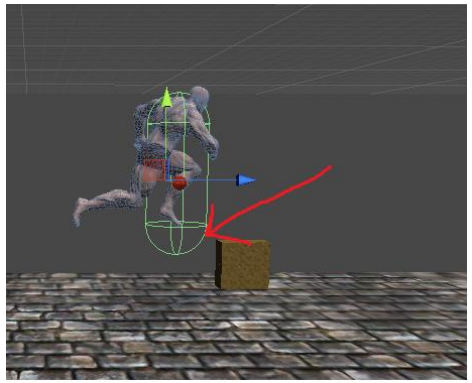
- Inconsistency of vistual feedback and real hand motion.

  --A Survey on Simulation for Weight Perception in Virtual Reality

- Why? Because objects in VR space are constrained by the map design and the physics engine, but the user has no any reference or limitations in the VR activity area of reality.

example

- For example, when the avatar encounters an obstacle, the current VR visual only can show the character is unable to move forward, and according to most studies will only have resistance force or vibration to provide interaction. But the ideal effect is that the user should feel the forward force of the character and the resistance of the obstacle, more specifically, the driving force of the legs and the resistance from the touch point.



purpose

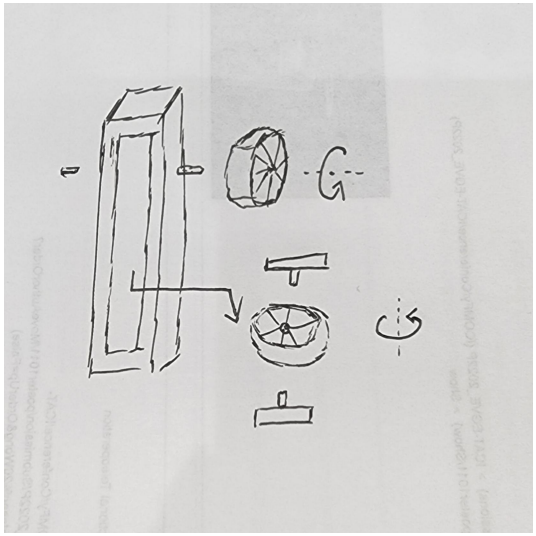
- This project is designed to reveal the motion state of the object or avatar under the VR environment, and give feedback to the user, in order to enhance the user's ability to manipulate the object so that the user is more aware of the interaction with the currently manipulated thing.

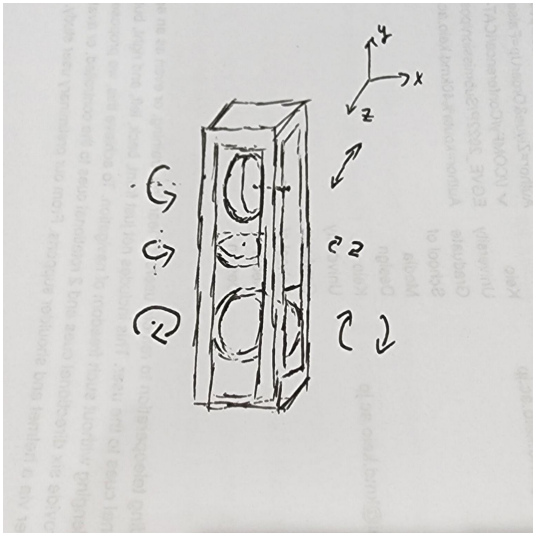
- The motion state is the overall motion state of the object, and is not limited to a single force situation, or it can also represent the motion state of a small part.

- Through such motion state feedback, aim to enhance the user's operation under the VR environment, can help user understand the current object's motion state, enhance the synchronization rate and connection between the user and the manipulated object, enhance the VR immersion. Can also be applied with telexistence. Make the robot easier to operate, and help operater quickly understand the movement state of various parts of the robot.

methods-1

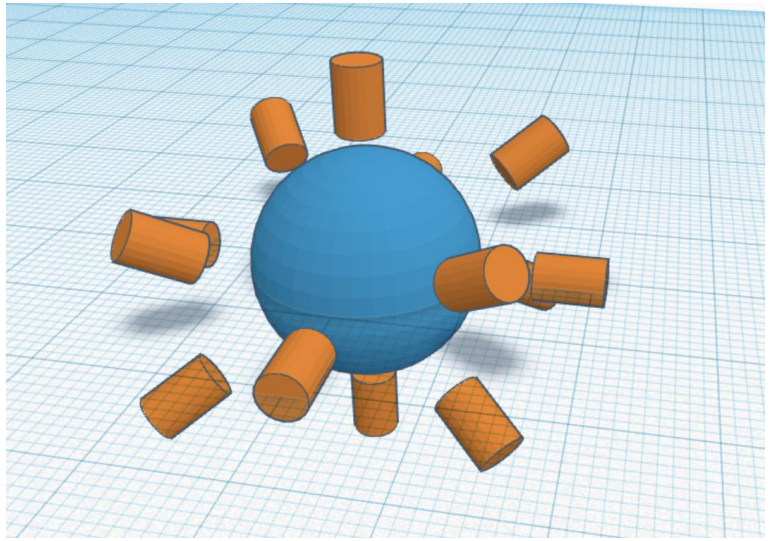
- Handheld controller, set some belt-winding wheel structure in the center part, and the user can feel the motion state of the object by touching these wheels by hand,the goal is to set 3 wheels to achieve 3dof feedback including front and back, left and right, up and down.

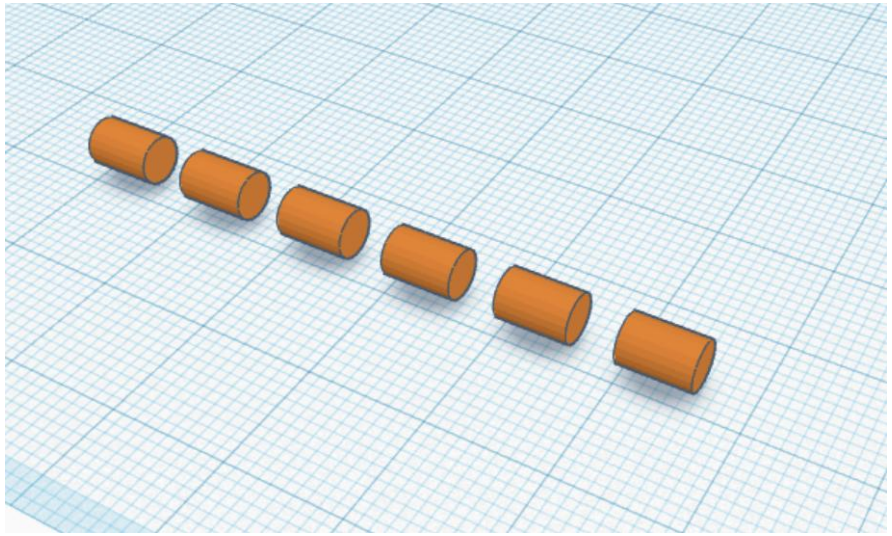




methods-2

- A large number of haptic motor are used in superposition, and the full range of feedback or series structure can simulate the whole process of linear motion.





application

- dynamic object, such as vr driving
- avatar, such as the character
- a part of the avatar, such as arm or handheld object
- a physical thing, such as toto
- a part of a physical thing, such as robotic arm